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Extraction Characteristics of a Low-energy Ion Beam System with a Remote Plasma Chamber

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Low-energy beams of ions were extracted from a dual-chamber plasma ion source system. The first chamber is a cylindrical quartz chamber terminated by stainless steel flanges with one flange having a gas inlet port. A 6 mm diameter copper tube is wound around the side of the chamber to realize an antenna configuration. Inductively coupled discharge is excited via 13.56 MHz radio-frequency (rf) power with autotuning matching system through the antenna. The plasma is driven into another chamber using a "launch" and "steer" electromagnetic coils. In the second chamber, a sputtering target, backed by water-cooled SmCo magnets, is placed which can be independently biased by a dc potential to control the sputtering yield. The surface of the target is parallel to flow of the discharge from the first chamber. Opposite the target is a dual-electrode ion extraction configuration capable of extracting low-energy ion beams.

In the present scheme, argon (Ar) plasma is excited in the first chamber and driven into the second chamber where a liquid gallium (Ga) is poured onto a tungsten holder. An optical emission spectrometer connected to a fiber optic cable. The other end of the cable was placed near the viewport. The line of sight of the fiber optic cable is positioned just above the surface of the target. The emission spectra revealed species of Ar as well as Ga. The intensities of the Ga emission line increases with increasing target bias. Ion beam transport characteristics were monitored using a lab-fabricated ion energy distribution analyzer as well as *ExB* mass analyzer. Results indicated the extraction of ions at different extraction potentials with well-defined beams from 70 to 100 V at different rf powers and gas pressures. Mass spectral analyses from the *ExB* probe showed the extraction of Ar and Ga ions at different target bias, extraction potentials and rf powers. Upon the addition of minute amounts of nitrogen, formation of gallium nitride films on a silicon substrate was realized.

References

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